Corresponding changes have been made to several of the drawing figures. No new matter has been added.

In the Drawings:

Please amend Figs. 3, 5, 8, 9, 12, 13, 14A and 14B, as shown in the attached "Annotated Marked-up Drawings." The changes to Figs. 3, 5, 8, 9, 12, 13, 14A and 14B all add element numbers and lead lines to designate an element already designated by the same number in a different figure in the application as filed. These changes are intended to clarify the description, by more comprehensively indicating elements described in the detailed description of the specification, in all of the drawings. Replacement drawing sheets are also enclosed.

In the Claims:

Please add new claims 35-42, as shown on the attached claim sheets which include all pending claims.

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Respectfully submitted,

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**REPLACEMENT SPECIFICATION PARAGRAPHS**

Please amend the following paragraphs as indicated below:

**[0036]** Turing to Fig. 5, the processor 16 includes an upper rotor 26 that is engageable to a lower rotor 28 to form a processing chamber 51 (shown in Fig. 8). In the illustrated embodiment, the workpiece 24 ~~is a round wafer having~~ has flat upper and lower surfaces.

**[0037]** The upper rotor 26 is preferably annular with a relatively large central opening ~~or bore~~ 32. The ~~bore~~ opening 32 preferably has a diameter that is 20-80%, 30-70%, or 40-60% greater than the diameter of a workpiece 24. For example, if the processor is configured to process 200 mm diameter wafers, the diameter of the ~~bore~~ opening 32 is preferably between 100 and 150mm in diameter, more preferably approximately 125mm in diameter.

**[0038]** One or more pneumatic air cylinders 38 or other actuators are attached to the support plate 34 for raising and lowering the upper rotor 26 between the open position illustrated in Figs. ~~2 and 4,~~ 4 and 5, and the closed position illustrated in Figs. 7-9.

**[0040]** ~~The~~ As shown in Figs. 5 and 8, workpiece 24 is preferably supported in the processing chamber on a plurality of lower supports 27 extending upwardly from the lower rotor 28. Upper support pins 29 on the upper rotor 26 generally tend to limit upward movement of the workpiece off of the lower supports 27, as illustrated in Fig. [[6]] 5. The workpiece 24 may alternatively be secured, as described in U.S. Patent No. 6,423,642.

**[0041]** Referring to Fig. 5, an annular housing 55 is attached to the plate 34. An annular flange 43 on the upper rotor 26 ~~extends into~~ is located within an annular slot 53 in the housing 55. A lower magnet ring 57 is attached on top of the flange 43. The upper rotor 26, the flange 43 and magnet ring 57 form an upper rotor assembly 59 which spins as a unit within the housing 55. The upper rotor 26 preferably has an inner PVDF or Teflon (Flourine resins) liner 61 attached to a metal, e.g., stainless steel ring 63, which supports the flange 51. The lower rotor is also preferably PVDF or Teflon. Three pins 52 extend up at the perimeter of the lower rotor 28 for engagement or insertion into openings or receptacles 54 in the upper rotor. The pins 52 have tapered conical tips to align the upper rotor with the lower rotor, as they are brought together. The pins 52 also transmit torque from the lower rotor to the upper rotor, as the rotors spin together as a rotor unit [[35]] during processing.

**[0042]** [[A]] Referring still to Fig. 5, a ring plate 67 is attached to the housing 55. The top end of the upper rotor 26 extends up through the ring plate 67. An upper magnet ring 69 is attached to the ring plate 67. The upper magnet ring 69 repels the lower magnet ring 57. The ring plate 67 has a conical section 71 which overlies and is attached to the plate 34. The plate 34, housing 55, ring plate 67 and conical section 71, and the upper magnet ring 69, form a housing assembly 73, which moves vertically via the actuators 38, but does not rotate. Rather, the upper rotor assembly 59 rotates within the stationary housing assembly 73. As shown in Fig. 5, with the processor 16 in the open or up position, the flange 43 of the upper rotor assembly 59 rests on the annular lip or ledge 77 of the housing 55, with no other contact between the rotor

assembly 59 and the housing assembly 73. Anti-clocking pins 58 (Fig. 8) extend up from the lip 77 into the flange 43 when the processor is in the open or up position, to keep the upper rotor in angular alignment with the lower rotor.

[0043] As shown in Fig. 8, with the processor 16 in the down or closed position, ~~the upper rotor assembly 59 is floating or suspended within the housing 55, i.e.,~~ there is no physical contact between the upper rotor assembly 59 and any part of the housing 55 or housing assembly 73. The repelling force of the magnet rings 57 and 69 drives the upper rotor assembly 59 down into contact with lower rotor 28, without physical contact. The magnet rings 57 and 69 may be replaced by individual magnets, electro-magnets or other magnetic elements.

[0044] Since the upper rotor 26 ~~is suspended and there is~~ has no physical or mechanical connection ~~between the upper rotor 26 or~~ with the upper rotor assembly 59, and the surrounding structure, such as the housing 55, plate 67 or plate 34, the upper rotor 26 can automatically align itself with the lower rotor 28, when they are brought together. The need for precise alignment of the upper rotor to the lower rotor is therefore avoided. In addition, as there is no physical contact between the fixed housing assembly 73 and the rotating rotor assembly 59 during processing, the potential for generating contaminant particles is greatly reduced.

[0045] A face seal or other sealing element 31, shown in Fig. 5, may be used to form a seal between the upper and lower rotors 26, 28 when they are brought together. For some applications, no seal is needed. The upper and lower rotors 26, 28 preferably contact one another only at the seal. The seal may be located on an interior face of

one or both of the rotors 26, 28, and is preferably located around the perimeter of the rotors.

[0046] ~~When~~ Referring to Fig. 8, when the rotors 26, 28 are brought together, they form a combined rotor unit 35 rotatable via a motor 39 supported on a base 40. The motor 39 is contained in a motor housing 37 attached to a base plate 40 or the frame 12. A motor rotor 75 is joined to a backing plate 41 which is attached to and supports the lower rotor 28. As shown in Fig. 5, the motor rotor 75 has a diameter which is at least 20, 30, 40, 50, 60, 70, or 80% of the diameter of the workpiece. This allows for improved dynamic balancing of the system, and less vibration. [[A]] Turning back to Fig. 8, a barrier ring 78 forms a tortuous path with the bottom of the backing plate 41. This helps to reduce migration of any particles from the motor outwardly and up towards the workpiece. A conical depression at the center of the lower rotor forms a sump 81 which collects and drains away stray liquid. Drain outlets 30 extend through the upper rotor, as shown in Fig. 5.

[0047] The large ~~central bore 32~~ diameter in the motor 39 provides a ~~large~~ torque advantage as compared to conventional motors ~~having smaller central openings~~. As a result, the motor 39 has greater rpm and acceleration capabilities than typical motors used in workpiece processing systems. For example, the large bore motor 39 can accelerate from 0 to 1800 rpm in approximately 2 to 4 seconds, as compared to motors used in typical workpiece processing systems that generally accelerate from 0 to 1800 rpm in approximately 14 to 18 seconds. Additionally, motors typically used in workpiece processing systems have maximum rotational velocities of 1800 to 2000 rpm. The

large bore motor 39, conversely, preferably has a maximum rotational velocity of 3800 to 4200 rpm, or approximately 4000 rpm. By using a motor 39 with greater rpm and acceleration capabilities, the workpiece processing system 10 ~~exhibits decreased drying times, due to the very thin film of liquid that is formed on a workpiece surface during drying, as a result of the faster spinning rate, and also has a higher throughput, due to the decrease in overall processing times.~~ can dry workpieces more quickly.

**[0048]** When the rotor unit 35 rotates, air is drawn into the processing chamber 51 through the opening or bore 32 in the upper rotor 26. The ~~bore~~ opening 32 is ~~relatively~~ large~~, and~~ relative to the chamber outlets~~ are restricted to a much smaller cross section area~~. This creates a low pressure differential within the processing chamber. This low pressure differential results in air flowing into the processing chamber at a low velocity. As a result, significantly fewer contaminant particles are likely to be drawn into the processing chamber by the incoming airflow, in comparison to existing designs. This reduces the chances of the workpiece becoming contaminated.

**[0049]** As illustrated in Figs. 7-9, an upper nozzle 42 or fluid applying device ~~extends into the bore 32 in~~ can be positioned within the upper rotor 26. The nozzle 42 supplies one or more processing fluids to an upper surface of the workpiece 24. Additional nozzles may be provided for separately supplying processing chemicals, rinsing fluids, and/or drying fluids or gases[[, or a]]. Alternatively, a single nozzle 42 may be used to supply all of the fluids required for processing.

**[0050]** The upper nozzle 42 is attached to an end of a relatively inflexible upper fluid delivery tube or line 44. The upper fluid delivery line 44 is attached to a motorized lifting and rotating mechanism 46, which can raise and lower, as well as pivot, the upper fluid delivery line 44 and the upper nozzle or outlet 42 in a back and forth alternating movement. ~~Accordingly, the upper nozzle 42 is moveable above the upper workpiece surface for distributing processing fluid to different portions of the upper workpiece surface.~~ Additionally, the upper nozzle 42 may be lifted up and out of the ~~bore 32~~ upper rotor 26 and pivoted away ~~from the processing chamber~~ for processing steps not requiring a nozzle, or so that the upper rotor 26 may be raised into the open or workpiece-receiving position. ~~While the bore in the upper rotor may have a smaller diameter than that of the workpiece, the upper nozzle 42 is preferably able to distribute processing fluid to the entire workpiece surface, due to the mobility of the upper nozzle 42.~~

**[0051]** As illustrated in Fig. 10, ~~the upper fluid delivery line 44 or the~~ upper nozzle 42 may include a fluid collection area 45~~, or "Z-trap," for collecting processing fluid after fluid delivery to the processing chamber is discontinued~~. In existing systems, there is a potential for excess fluid to drip from the upper nozzle ~~or tube~~ onto the workpiece after fluid delivery has been stopped. This can lead to workpiece contamination or other defects. Suck-back and gas purging techniques have been used in an attempt to completely empty the fluid delivery tube, but residual drops often still occur. Thus, the collection area 45 may be ~~employed, in conjunction~~ used with suck-back or purging

techniques, to collect the residual fluid so that it does not drip into the processing chamber.

**[0052]** The fluid collection area 45 is preferably formed by a first tube section 47 extending upwardly at an angle~~, connecting into a second section 49 is included in~~ from the upper fluid delivery line 44~~ or upper nozzle 42 so that processing fluid is directed toward the processing chamber~~. The fluid collection area 45 is preferably large enough to contain several drops of fluid~~ that are purged or sucked back into the collection area 45~~. As illustrated in Fig. 11, a nozzle 42 incorporating a collection area 45 ~~or Z-trap~~ may be manufactured as a separate component that may be attached to the end of the upper fluid delivery tube or line 44.

**[0054]** In a preferred embodiment, as illustrated in Fig. 5, an air supply line or snorkel 92 has an inlet or opening 94 located vertically above the processing chamber 51. Typically, the inlet 94 is near the top of the system enclosure 15, shown in Fig. 1. A vertical riser section 96 of the snorkel 92 connects into a horizontal section 98 and into a valve 90, which is joined to the lower ~~nozzle~~ fluid delivery line 50. When the rotor assembly spins, clean air (not recycled air) is drawn through the snorkel 92 and is supplied to the bottom surface of the workpiece. The low air pressure adjacent to the center of the spinning rotor assembly draws the clean air in through ~~a trench in~~ the lower nozzle 50. The air sprays upwardly from the lower nozzle 50 onto the lower surface of the workpiece. Drying of the lower surface is therefore achieved more quickly.

[0056] As ~~illustrated in Figs. 4-9~~ shown in Figs. 4, 5 and 8, an annular drain assembly 70 is positioned around the rotor unit 35. The drain assembly 70 is preferably vertically moveable via a lifting mechanism or elevator 72. The elevator 72 includes an armature 74 attached to the drain assembly 70. A motor 79 turns a jack screw 76 to raise and lower the armature 74 and the drain assembly 70.

[0057] The drain assembly 70 includes a plurality of drain paths that are separately alignable with the outlets 30 in the processing chamber. Three drain paths 80, 82, 84 are shown in Figs. 5 and [[6]] 8, but any desired number of drain paths may be included in the drain assembly 70. Multiple drain paths are provided so that different processing ~~chemistries, as well as~~ liquids (including deionized (DI) water), may be removed from the processing chamber ~~along~~ through separate paths[[,]]. ~~which eliminates~~ This helps to avoid cross-contamination between the processing ~~chemistries and the DI water.~~ liquids.

[0058] Turning to Figs. 12-14B, the drain paths 80, 82, 84 each preferably lead to a separate drain tube 80a, 82a, 84a, respectively, which ~~extend~~ lead out of the processor 16 ~~from below the drain paths 80, 82, 84~~. The drain assembly 70 also preferably includes an exhaust plenum 88~~, which pulls exhausts uniformly around the diameter of the drain assembly 70. The exhaust plenum 88 communicates with the processing chamber via a plurality of exhaust ports 89.~~ shown in Figs. 12 and 13 which draws in exhaust. Exhaust ports 89 extend through the drain assembly 70 and connect into the exhaust plenum. An exhaust tube 86 ~~is preferably attached to the drain~~

~~assembly 70, via welding or another suitable means, for providing~~ provides an exhaust from the system.

**[0059]** When the upper rotor member 26 is in the open or ~~workpiece-receiving~~ up position, the drain assembly 70 is preferably at its lowest position, adjacent to the base 40, as illustrated in Figs. 4-6. This allows for loading and unloading of a workpiece 24 into and out of the processor 16, as shown in Fig. 4. When the upper rotor 26 is lowered into the closed or processing position, the drain assembly 70 is raised by the elevator 72 to align one of the drain path 80, 82, or 84 with the outlets 30 in the processing chamber, as illustrated in Figs. 7-9.

**[0061]** The inner surface of the drain assembly 70 is preferably separated from the outer surface of the rotor unit 35 by a gap of approximately 0.125 to 0.250 inches, more preferably 0.175 to 0.200 inches. When the drain assembly 70 is lowered and/or when the upper rotor 26 is raised, ~~an airflow, or "lip exhaust," moves~~ air flows downward through the gap toward the system exhaust. This airflow entrains particles and fluids and pulls them away from the workpiece toward the system exhaust. As a result, when the drain assembly 70 is lowered, and the upper rotor 26 is raised to allow access to the workpiece, few, if any, particles and contaminants are present in the processing chamber. Thus, particle re-deposition on the workpiece is substantially reduced or eliminated.

**[0066]** As the rotor unit rotates, air is drawn into the processing chamber through the ~~bore~~ opening 32 in the upper rotor assembly 59 and housing assembly 73. As the ~~bore~~ opening 32 is relatively large, and the processing chamber 51 is substantially

closed, except at the outlets 30, ~~the~~ air flows through the processing chamber at a relatively low velocity, thus reducing the likelihood of entraining particles that could contaminate the workpiece. In a preferred embodiment, the air flowing through the processing chamber is filtered through one or more mini-environment filters to further reduce the likelihood that particles are delivered to the workpiece via airflow.

**[0070]** Similar steps may be performed for one or more additional processing fluids. A rinsing step may be performed after each processing step, or may be performed after all processing steps are completed. A drying step performed with isopropyl alcohol (IPA) vapor or another drying fluid may be performed after the final processing or rinsing step. In a preferred embodiment, one drain path is assigned to each type of processing fluid used, including the DI rinse water. Thus, cross-contamination between the different processing ~~chemistries~~ liquids, as well as the DI rinse water, is avoided. Alternatively, single use ~~chemistries~~ processing liquids may share a drain path with each other and/or with the DI rinse water.

**[0075]** 1. The ~~large central bore~~ opening 32 in the upper rotor 26 allows air to flow through the processing chamber at a low pressure differential. The resulting velocity of this airflow is relatively low due to the open inlet and restricted outlet at the chamber seal. This low velocity reduces the possibility of drawing particles into the chamber during processing.

**[0079]** 5. The motor 39 has exceptional torque capability, which allows the motor shaft to be more massive without significantly affecting performance. The upper and lower rotors 26, 28 are therefore a smaller portion of the total spinning mass. As a

result, the associated in-balance of the rotor unit (due to either machine tolerance or retained chemical volume) is less of a source of vibration. Additionally, the large ~~bore~~ motor diameter provides a torque advantage for the motor, thus allowing the motor to have greater rpm and acceleration capabilities than motors typically used in workpiece processing systems.

**[0080]** 6. The ~~bore~~ opening 32 allows for processing ~~chemistries~~ liquids to be applied to the workpiece in a more distributed way because the one or more upper nozzles can move relative to the workpiece center to distribute fluid. This is particularly important near the workpiece center where centrifugal force is a smaller factor, and where large volumes of processing chemistry may need to be applied in a short period of time, or where chemical processing is a function of refreshment rate.